The grassy balds on the Bunya Mountains, south-eastern Queensland: floristics and conservation issues

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Fensham, R.J., and Fairfax, R.J., (Queensland Herbarium, Department of Environment, Meiers Road, Indooroopilly, Queensland, Australia 4068) 1996. The grassy balds on the Bunya Mountains, south-eastern Queensland: floristics and conservation issues. Cunninghamia *4(3): 511–523.* Grassy balds occur on the Bunya Mountains, south-eastern Queensland (26°53'S, 151°34'E) in all topographic situations, surrounded by either eucalypt forest or rainforest and over an altitudinal range of 600–1100 m. An agglomerative clustering classification of the vascular flora of a sample of 59 of the 119 grassy balds derived three major groups: high altitude grassland on relatively shallow slopes (Group 1), mid- to high-altitude grassland on steep slopes (Group 3), and mid-altitude grassland (Group 4). *Poa labillardieri* is the most common dominant grass, although nearly 50% of Group 3 balds are dominated by either *Themeda triandra* or *Sorghum leiocladum*. Only about a quarter of the area of grassy balds occurring over 700 m and only 9 hectares, constituting less than 6% of those occurring under 700 m altitude, are reserved in the Bunya Mountains National Park. The four largest grassy balds occur outside the park. The rare species *Bothriochloa bunyensis, Haloragis exaltata* subsp. *velutina* and *Thesium australe* occur on the balds and their distribution and conservation status are discussed. Research from elsewhere indicates that *Thesium* is sensitive to grazing. Kikuyu (*Pennisetum clandestinum*), an exotic perennial grass, has the potential to completely replace native grassland species of the balds and an urgent management priority is its removal from those four balds where its extent is still limited. The wind-dispersed annual, Balloon cotton bush (*Gomphocarpus physocarpus*) is widespread on the balds, but does not appear to reduce native species richness. By 1991, about one quarter of the area of the balds in existence in 1951 had been transformed from grassland to forest or woodland. It is likely that the contraction of grassland coincides with a changed fire regime since the advent of European settlement. A fire management program should be developed that aims to minimize the invasion of forest species into the remaining grasslands.

Introduction

High-altitude grasslands (over 600 m) are not common in Queensland, because most montane areas are either of relatively oligotrophic substrate and support heathy vegetation or occur in areas of relatively high rainfall and support rainforest or tall eucalypt forest. There are grasslands on the Bunya Mountains (26°53'S, 151°34'E) , a north-westerly orientated basaltic massif on the Great Dividing Range 160 km WNW of Brisbane, in a variety of environmental situations within a matrix of rainforest and eucalypt forest (Webb 1964; Fensham & Fairfax in press). The grasslands known as 'balds' occur on a variety of aspects and slopes from the lower slopes and gullies at 600 m and cover the highest summit at 1100 m (Fensham & Fairfax in press). Some of

these grasslands are protected within the Bunya Mountains National Park that covers 19450 ha (Fig. 1). Grasslands have been described as 'Australia's most threatened ecosystem' (Kirkpatrick et al. 1995) throughout southeastern Australia. Montane grassland balds occur at Wollemi National Park, Barrington Tops and Dorrigo in New South Wales in similar environmental setting to the Bunya Mountains (J. Benson pers. comm.), but have not been described in the literature. Except for description of their environmental setting and discussion of their origin (Webb 1964; Fensham & Fairfax in press) there are also no published accounts of the vegetation of the grassy balds on the Bunya Mountains.

This paper seeks to describe the vegetation of the grassy balds of the Bunya Mountains using a numerically derived community typology. Conservation issues are assessed, including the botanical significance of the grasslands and ecological significance as probable anthropogenic artefacts. Management issues are discussed including those related to to the control of exotic plants and the use of fire as a tool to shape the composition and extent of the balds.

Methods

Field methods

The Bunya Mountains balds were mapped from aerial photographs (1: 25 000) taken in 1991. Fifty-nine balds out of a total of 119 were visited between January 1995 and April 1995, a period covering the flowering of most of the herbaceous flora. The sampled balds were selected to cover the range of environmental positions occupied by balds on the Bunya Mountains. Species nomenclature follows Henderson (1994). At each site all the vascular plant species occurring in a 10×2 m quadrat were recorded. Each quadrat was placed in what was assessed to be the most representative topographic position, slope and aspect for that bald. Other species within the bald were noted, which in combination with the quadrat list gives an overall list for the bald. The dominant grass was recorded and the abundance of the exotic grass Kikuyu (*Pennisetum clandestinum*) was assessed on the scale: 0 = absent; 1 = restricted to the edges of tracks; 2 = extending from tracks, but less than 50% of bald area invaded; 3 = more than 50% bald area invaded. The abundance of the tall exotic herb Balloon cotton bush (*Gomphocarpus physocarpus*) in each bald was assessed on the scale: 1 = absent; 2 = very sparse; 3 = common in localised situations; 4 = common and widespread.

The following data were collected for each sampled bald:

a) Location (Australian Map Grid co-ordinates from the 1: 50 000 map);

b) Mid-altitude (halfway between the lowest and highest elevations from 1: 50 000 map);

c) Modal slope (estimated according to the scale; flat (0–2%), gentle (3–8%), moderate (9–20%), steep (21–35%), very steep (> 35%);

d) Modal landscape position (ridgetop, mid-slope, footslope, valley/plain);

e) Most common surrounding vegetation (eucalypt forest, rainforest);

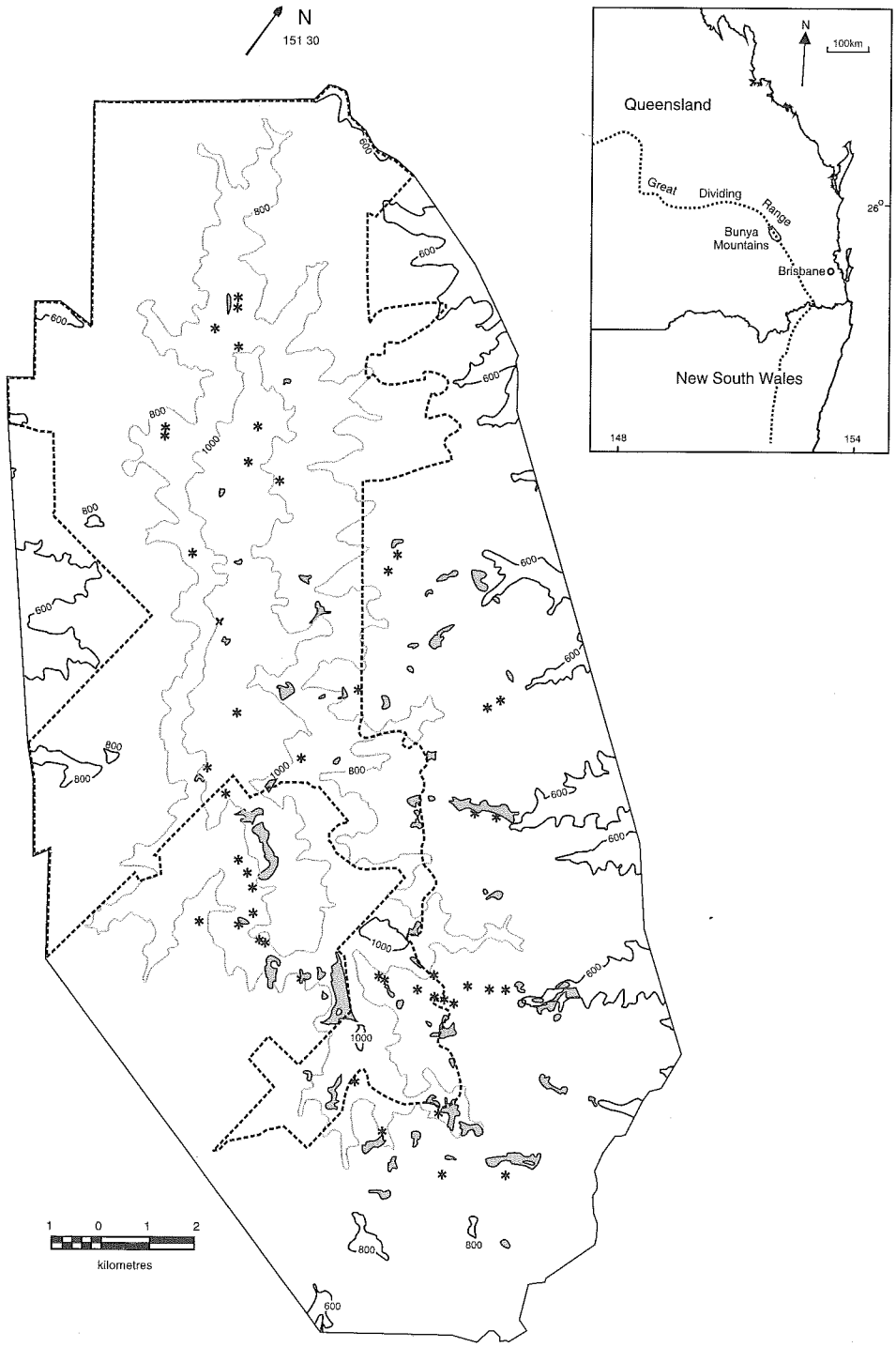

Fig. 1. Locality map showing the topography of the Bunya Mountains and the position of the balds in 1991. Balds too small to map are marked with an asterisk. The dashed line marks the boundary of the National Park.

f) The overall area in 1991, measured from aerial photographs, using 1 mm graph paper;

g) Surface rock cover (estimated according to the scale; absent, 0–5, 5–20, 20–50, > 50% of the surface area).

Analytical methods

The data were stored and manipulated within the DECODA software (Minchin 1991). The PATN software (Belbin 1988) was used for the classification using the group average procedure flexible-UPGMA (Unweigthed Pair Group using Arithmetic Averaging; see Sneath & Sokal 1973), a hierarchical agglomerative multivariate clustering technique that compares favourably in comparisons with other techniques given the task of recovering known configurations from generated data (Belbin et al. 1992; Belbin & McDonald 1993). The analysis was performed on presence–absence data for native species only, using the overall site list, following the removal of woody species with a mature height greater than 2 m, and the default settings in PATN that does not delete rare species and sets the dilation of the multivariate space at a recommended value (Belbin et al. 1992).

For the continuous variables differences between groups were tested using analysis of variance following ln (x + 1) transformation. For categorical variables the environmental association of groups was tested using the chi-squared test.

Native species richness was compared between those balds with *Gomphocarpus* abundance ratings of ≤ 2 and ≥ 3, using a t-test without any transformation given that a test showed that the species richness data was heteroscedastic.

Results

Community classification and description

The fifty-nine sampled balds represent about half of 119 extant grassy balds on the Bunya Mountains (Fig. 1). The balds are generally tussock grasslands (Fig. 2) and most frequently dominated by *Poa labillardieri* which is a common dominant of temperate grasslands and is near its northern limit on the Bunya Mountains. On this basis the balds may be regarded as a northern isolate of a temperate grassland type, although only 26 (15%) of the native vascular plant species have their known northern limit within 100 km of the Bunya Mountains (HERBRECS database, Queensland Herbarium).

All of the species known from the Queensland Herbarium database (HERBRECS) were relocated during this survey suggesting that although some spring geophytes may await discovery, the flora of the balds has been generally well sampled during this study. The recorded flora of the grassy balds, excluding trees, consists of 181 native taxa including subspecies (Appendix). The dendrogram was accepted at the five-group level, given that exploratory analysis indicated that lower levels of the hierarchy could not be distinguished on environmental grounds (Fig. 2). The full species list and percentage frequency of occurrence in the five UPGMA groups are presented in the Appendix. Thirty-four exotic taxa were present on the balds and

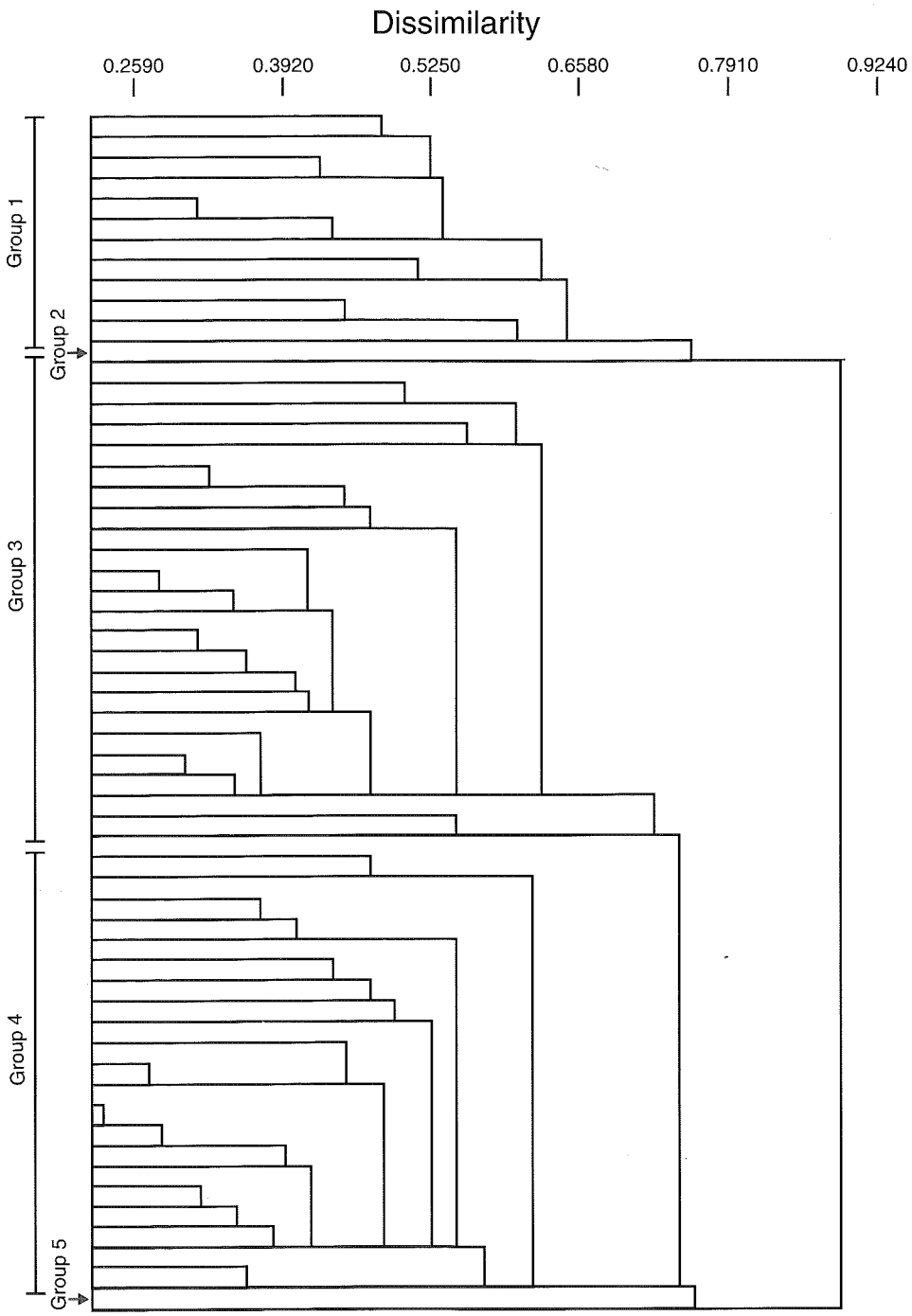

Fig. 2. UPGMA classification dendrogram.

these were excluded from the analysis. There was no association of the UPGMA groups with aspect according to the chi-squared test ($P > 0.05$) but the groups were positively associated with the landscape position categories (Table 1; chi-square = 22.9; $P < 0.001$). The association of the UPGMA groups with those bald characteristics on continuous numerical scales and the significance of differences between groups are shown in Table 2, and the associated frequency of the grass dominants with the groups is shown in Table 3.

Group 1 comprises relatively small balds at high altitude that have significantly lower slope angles than the only other relatively high altitude community (Group 3) having

Table 1. Association of UPGMA classificatory groups according to landscape position categories.

	UPGMA group					
	1	**2**	**3**	**4**	**5**	**Total**
Ridgetop	2	0	12	7	1	22
Midslope	7	1	9	4	0	21
Footslope	1	0	0	5	0	6
Valley/Plain	2	0	0	8	0	10
Total	12	1	21	24	1	59

Table 2. Mean values for seven characteristics of the sampled balds subdivided according to UPGMA classificatory group. The F values and significance of differences from oneway ANOVA are also shown. Groups 2 and 5 were not included in the comparison because they consist of single sites. Mean values between pairs of groups that are not significantly different according to Tukey's test are enumerated with the same letter.

	UPGMA group					ANOVA results	
	1	**2**	**3**	**4**	**5**	**df, error**	**F value**
Size 1991 (ha)	1.0^{A}	10.0	8.0^{B}	6.0^{B}	3.2	2, 53	8.77***
Altitude (m)	986^{A}	1015	862^{B}	685^{C}	988	2, 53	50.72***
Slope (%)	7.0^{A}	1.0	22.1^{B}	6.8^{A}	1.0	2, 53	10.88***
Rock cover (%)	8.8^{A}	2.5	8.8^{A}	3.3^{A}	12.5	2, 53	NS
Gomphocarpus physocarpus extent (see Methods)	2.2^{A}	3.0	2.8^{AB}	3.0^{B}	3.0	2, 53	3.24*
No. of native species	26.9^{A}	9.0	37.5^{B}	34.6^{B}	47.0	2, 53	6.57**
No. of exotic species	3.3^{A}	3.0	5.7^{B}	4.3^{AB}	8.0	2, 53	5.50**

*** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$; NS $P > 0.05$

Table 3. The dominant grass species of the sampled balds according to UPGMA classificatory group.

	UPGMA group				
Dominant species	**1**	**2**	**3**	**4**	**5**
Poa labillardieri	11	1	11	17	1
Themeda triandra	0	0	6	0	0
Sorghum leiocladum	1	0	4	7	0

sufficient members for statistical testing. Group 1 balds are almost exclusively dominated by *Poa labillardieri* and are relatively species-poor compared with the other larger groups. The sedge *Carex declinata* is the strongest indicator of this group although it is not always present and can occur in other groups.

Group 2 is a single site at 1015 m altitude dominated by *Poa labillardieri* and it is distinguished form other groups by its low species richness rather than by any particularly faithful species associates. The site is outside the National Park and amongst housing development, but despite these circumstances the reason for the depauperate species composition of this site is not known.

Group 3 sites are mid- to high-altitude, relatively large balds and were only sampled on ridgetops and midslopes. Mean slope angles are considerably higher than for the other groups. The balds comprising this group are relatively species-rich and can be dominated by *Poa labillardieri, Sorghum leiocladum* or *Themeda triandra*. The herbaceous daisies *Bracteantha bracteata, Chrysocephalum apiculatum* and *Picris angustifolius* are faithful indicators for the group.

Group 4 sites are distinguished from other groups because they occupy mid-altitudes, but can occupy a variety of landscape positions. *Poa labillardieri* and *Sorghum leiocladum* dominate these balds. The grasses *Aristida ramosa* and *Panicum effusum* var. *simile*, and the low shrub *Sida subspicata* are frequent associates of this group, and are relatively infrequent or absent in other groups.

Group 5 consists of one bald situated on a high-altitude ridgetop and is 3 km from the nearest bald in the north-west of the study area. The grasses *Chloris divaricata* and *Tripogon loliiformis*, the sedge *Cyperus squarrosus*, the herbs *Hibiscus trionum, Portulaca bicolor, Rhodanthe anthemoides, Solenogyne bellioides* and *Velleia paradoxa* are all either infrequent in or absent from all other groups (Appendix).

Land tenure

The almost total eradication of low altitude grasslands by cultivation in the Darling Downs (Fensham submitted) mirrors the plight of this vegetation type throughout south-eastern Australia (Kirkpatrick et al. 1995). The rarity of lowland grassland confers great conservation value to the low altitude balds on the Bunya Mountains. Unfortunately the nine hectares of grassy bald at less than 700 m altitude in the Bunya Mountains National Park (Table 4) represents the only reservation of low altitude grassland in south-east Queensland. Even the high altitude balds are poorly represented in the National Park with only 27% of their area in the National Park (Table 4) and the four largest balds are outside the park boundary (Fig. 1). Alone of the five groups of balds defined earlier, Group 2 does not occur in the National Park and Group 4 is extremely poorly represented.

The grassy balds in State Forest on the north-eastern flanks of the Bunya Mountains are not effectively managed for conservation as domestic cattle herds are present in these areas under the provision of grazing leases. The inclusion of these areas to the National Park would greatly improve the reservation status of grassland in Queensland and allow for appropriate management (see below).

Rare species

Three species on the Bunya Mountains balds are listed on the protected plant schedule of the *Nature Conservation (Wildlife) Regulation 1994, Subordinate Legislation no. 474 of 1994* (Queensland) and all three are also listed by Briggs and Leigh (1988). The grass *Bothriochloa bunyensis* was first discovered on the Bunya Mountains where it is relatively widespread (Appendix). It has since been found on a grassy bald on a basaltic section of the Great Dividing Range 175 km to the south-east of the Bunya Mountains; it appears to be endemic to montane grasslands in south-east Queensland.

Thesium australe is a herbaceous root parasite (principally of *Themeda triandra*) recorded from two Group 4 sites, one population of one individual of which was noted in the National Park. The species is listed in Queensland as vulnerable where it is rare in remnant grassy vegetation mostly on roadsides and rail reserves in the Darling Downs district. Its general absence from paddocks grazed by domestic stock suggests that the species is probably sensitive to grazing (Griffith 1992; Fensham unpublished data). The vast reduction in its inland grassy habitat from south-east Queensland to Tasmania (where it is now considered extinct — Kirkpatrick et al. 1991) confers considerable conservation significance on populations in the Bunya Mountains grassy balds. The largest known population on the Bunya Mountains is on a bald in State Forest that is largely inaccesible to cattle. Little is known of the fire ecology of *Thesium australe* (Griffith 1992), although its response to a single fire is currently the target of investigation (J. Cohn pers. comm.).

Haloragis exaltata subsp. *velutina* was found on one group 5 site and is restricted to northern New South Wales and south-eastern Queensland where its primary habitat seems to be the margins of rainforest. The species grows to about 1 m which is much larger than most members of the Haloragaceae. There is little recorded information of the ecology of the species.

Exotic species

The flora of the Bunya Mountains balds includes 34 exotic species. Of all of these species, the rhizomatous grass *Pennisetum clandestinum* poses the greatest threat to the natural integrity of the grasslands. It has the capacity to almost completely replace native species and to form monospecific swards that are maintained as lawns by wallaby grazing (mostly red-necked wallaby). Expansive exotic lawns dominated by the species almost totally occupy two balds and *Pennisetum clandestinum* is displacing intact native grassland in another two balds. It is also present on disturbed ground in another four

Table 4. Areas (ha) and percentages of balds in two altitude classes on the Bunya Mountains according to land tenure categories.

	Land tenure			
Altitude class	**National Park**	**State Forest**	**Freehold land**	**Total area**
Low altitude (590–700 m)	8.8 (5.5%)	130.8 (82.5%)	19.0 (12.0%)	158.6 (100%)
High altitude (701–1140 m)	69.4 (27.2%)	70.9 (27.8%)	115.0 (45.0%)	255.3 (100%)
Total	78.2 (18.9%)	201.6 (48.7%)	134.0 (32.4%)	413.8 (100%)

balds, two of which are the largest balds on the mountains. It would be probably be a futile task to try to eradicate the species from the balds where it dominates large areas. However, it is of the utmost management priority that attempts are made to eradicate *Pennisetum clandestinum* from the four balds which currently have minor infestations. Unfortunately, three of the four minor occurrences are on land of freehold title.

Gomphocarpus physocarpus is extremely widespread and occurs in all groups except the single site forming Group 2 (Appendix). Both correlation and the t-test indicated greater native species richness in balds with *Gomphocarpus* bush invasion, although differences were not significant ($P > 0.05$).

Gomphocarpus is a wind-dispersed ephemeral and anecdotal evidence suggests that it can become abundant following fire (D. Sansom pers. comm.). However, its density decreases as the tussock grasses and intertussock species increase their cover during the post-fire interval.

There are two perennial exotic grasses (*Eragrostis curvula* and *Setaria sphacelata* var. *sericea*) that are not widespread on the Bunya Mountains, but that may have the ability to dominate grassland and invade without the stimulant of mechanical disturbance. The former of these species poses a major management problem in grasslands of the Monaro district of New South Wales (J. Benson pers. comm.) and the small isolated populations of both these grasses should be a priority for eradication.

Most of the other herbaceous exotic plants are relatively innocuous intertussock species that do not seem to displace native species (e.g. *Centaurium erythraea, Conyza bonariensis, Veronica bonariensis*). Others are invaders of disturbed areas (e.g. *Chloris virgata, Tagetes minuta*) and present no major threat to the native vegetation of the balds given current park management that attempts to minimize such disturbance.

Two woody exotics, *Lantana camara* and groundsel bush *Baccharis halmifolia* are occasional invaders of grassy balds, although they are relatively rare compared to native trees and shrubs (see below).

Forest invasion

Fensham & Fairfax (in press) indicate that 26% of the area of balds on the Bunya Mountains has been invaded by woody forest species during the period 1951–1991. The most common invading species are *Acacia implexa, A. irrorata, A. maidenii, Cassinia laevis, C. quinquefaria* and *Eucalyptus tereticornis*.

The rapid rate of forest invasion is incompatible with a hypothesis explaining the existence of balds as remnants of a Holocene climate (e.g. Webb 1964). Fensham & Fairfax (in press) have argued that most balds on the Bunya Mountains are disclimax communities resulting primarily from aboriginal burning. If this view is correct the Bunya Moutains balds have cultural as well as biological values and the case for management directed to their maintenance is strengthened. The decision to manage for the maintenance of a vegetation type of limited occurence or to allow natural succession to take its path is in the end a philosophical question. However, the question has been addressed in the Southern Appalachians, and based on aesthetic, cultural heritage and biodiversity values a management policy using fire for bald

maintenance has been recommended (Lindsay & Bratton 1979). Such a policy on the Bunya Mountains would require determination of the optimum fire regime. Fire management should not only aim to restrict the spread of woody species but should also aim to minimise the establishment of balloon cotton bush. The senior author, in conjunction with the rangers in the National Park, is embarking on a simple monitoring procedure seeking to relate post fire reduction in woody species and ballon cotton bush with seasonal, environmental and weather conditions during burning of grassland on the Bunya Mountains.

Appropriate fire management must be employed regardless of tenure for the range of grassy balds on the Bunya Mountains to survive. Positive public perception of fire in grasslands may need to be nurtured given the high visitation rates to this National Park and the experience elsewhere of visitors reacting negatively to fire in conservation areas.

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Appendix

Percentage frequency of vascular plant taxa according to UPGMA classificatory group. Number of balds in each group: Group 1 = 12, Group 2 = 1, Group 3 = 21, Group 4 = 24 and Group 5 = 1.

	UPGMA group				
	1	2	3	4	5
PTERIDIOPHYTA					
Adiantaceae					
Adiantum aethiopicum	8	–	5	–	–
Adiantum capillusveneris	–	–	5	–	–
Blechnaceae					
Doodia aspera	8	–	–	–	–
Dennstaedtiaceae					
Pteridium esculentum	17	–	19	4	–
Dryopteridaceae					
Lastreopsis decomposita	8	–	–	4	–
Ophioglossaceae					
Botrichium australe	8	–	10	–	–
Ophioglossum lusitanicum	25	–	–	25	100
Sinopteridaceae					
Cheilanthes distans	33	–	24	8	–
Cheilanthes sieberi	42–	52	50	–	
ANGIOSPERMAE					
Acanthaceae					
Pseuderanthemum variable	8	–	10	4	–
Rostelullaria adscendens	–	–	–	42	–
Amaranthaceae					
Alternanthera nana	33	–	5	21	–
Alternanthera nodiflora	–	–	–	4	–
Nyssanthes diffusa	25	–	19	4	–
Apiaceae					
Centella asiatica	17	–	5	8	100
Ciclospermum leptophyllum	8	–	10	13	–
Daucus glochidiatus	–	–	9.5	–	–
Hydrocotyle laxiflora	100	100	100	79	100
Araceae					
Typhonium brownii	8	–	–	4	–
Asclepiadaceae					
*Araujia sericifera**	–	–	5	–	–
Cynanchum bowmanii	–	–	–	4	–
*Gomphocarpus physocarpus**	75	–	95	92	100
Asteraceae					
*Bidens pilosa**	8	–	19	–	–
Brachyscome microcarpa	17	–	67	25	100
Bracteantha bracteata	8	–	81	–	–
Calotis lappulacea	–	–	–	8	–
*Carduus thoermeri**	8	–	10	4	–
Centipeda minima	–	–	–	4	–
Chrysocephalum apiculatum	–	–	62	13	–
*Cirsium vulgare**	50	100	48	33	–
*Conyza bonariensis**	8	–	88	29.2	100
*Erechtites valerianifolia**	–	–	5	–	–
Euchiton sphaericus	33	–	24	13	–
Euchiton sp.	8	–	10	–	–
Glossocardia bidens	–	–	19	29	–
Hypochoeris microcephala var. *albiflora**	–	100	5	13	100
*Hypochoeris radicata**	8	–	33	8	–
Lagenifera stipitata	–	–	5	–	–
Picris angustifolius	–	–	67	–	–
Podolepis jaceoides	–	–	19	–	–
Rhodanthe anthemoides	–	–	–	–	100
Schkuhria pinnata var. *abrotanoides**	–	–	–	4	
Senecio hispidulus	8	–	19	17	–
Senecio quadridentatus	–	–	5	4	–
Sigesbeckia orientalis	8	–	14	4	–
Solenogyne bellioides	–	–	–	4	100
Sonchus oleraceus	–	100	14	–	–
*Tagetes minuta**	–	–	5	13	–
Vittadinia dissecta var. *dissecta*	–	–	–	13	–
Vittadinia sulcata	–	–	5	21	100
Vernonia cinerea	–	–	29	38	–
Wedelia spilanthoides	–	–	10	–	–
*Zinnia peruviana**	–	–	–	13	100
Bignoniaceae					
Pandorea pandorana	8	–	10	4	–
Boraginaceae					
Cynoglossum suaveolens	8	–	–	–	–
Brassicaceae					
Cardamine hirsuta	17	–	14	8	100
*Lepidium africanum**	–	–	–	–	100
Cactaceae					
*Opuntia stricta**	8	–	10	201	100
Caesalpineaceae					
Senna barclayana	17	–	–	50	–
Campanulaceae					
Wahlenbergia gracilis	67	–	100	96	100
Caryophyllaceae					
*Polycarpon tetraphyllum**	8	–	–	–	–
Chenopodiaceae					
Chenopodium pumilio	33	100	5	25	–
Einadia hastata	25	–	14	8	–
Clusiaceae					
Hypericum gramineum	8	–	81	29	–
Commelinaceae					
Commelina cyanea	75	100	52	25	100
Murdannia graminea	–	–	–	4	100
Convolvulaceae					
Convolvulus erubescens	–	–	4	–	–
Dichondra repens	8	–	14	42	–
Evolvulus alsinoides	–	–	14	25	–
Ipomoea plebeia	–	–	–	4	–
Crassulaceae					
Crassula sieberiana	17	–	19	–	100
Cyperaceae					
Carex breviculmis	8	–	52	33	–
Carex declinata	83	–	33	17	–
Carex inversa	8	–	33	63	100

	UPGMA group				
	1	2	3	4	5
Cyperus fulvus	33	–	62	88	100
Cyperus gracilis	67	–	52	75	–
Cyperus laevis	8	–	10	–	–
*Cyperus sesquiflorus**	–	–	–	4	–
Cyperus sphaeroideus	17	–	–	–	–
Cyperus squarrosus	–	–	–	–	100
Fimbristylis dichotoma	42	–	67	88	100
Fimbristylis nutans	–	–	5	–	–
Lepidosperma laterale	–	–	29	–	–
Scleria mackaviensis	8	–	10	17	–
Epacridaceae					
Lissanthes strigosa	–	–	–	4	–
Euphorbiaceae					
Euphorbia dallachyana	–	–	5	13	–
Euphorbia drummondii	–	–	5	–	–
Phyllanthus virgatus	–	–	48	63	10
Poranthera microphylla	–	–	10	–	–
Fabaceae					
Crotalaria mitchellii subsp. *laevis*	–	–	10	13	–
Crotalaria mitchellii subsp. *mitchellii*	–	–	5	–	–
Crotalaria montana	–	–	–	4	–
Desmodium brachypodum	–	–	29	13	–
Desmodium varians	8	–	71	63	–
Glycine clandestina	17	–	29	8	–
Glycine latifolia	8	–	38	21	–
Glycine tabacina	42	–	71	42	–
Lespedeza juncea	8	–	86	58	–
*Trifolium repens**	8	–	5	–	–
Zornia dyctiocarpa	–	–	33	21	–
Gentianaceae					
*Centaurium erythraea**	17	–	29	33	–
Geraniaceae					
Geranium solanderi	42	–	67	58	100
Goodeniaceae					
Velleia paradoxa	–	–	5	–	100
Haloragaceae					
Haloragis exaltata subsp. *velutina*	–	–	–	4	–
Haloragis heterophylla	8	–	14	4	–
Juncaceae					
Juncus aridicola	8	–	–	–	–
Juncus continuus	25	–	–	4	–
Juncus homalocaulis	–	–	–	4	–
Juncus usitatus	92	100	14	29	–
Luzula flaccida	–	–	10	–	–
Lamiaceae					
Ajuga australis	–	–	24	13	100
Mentha gracilis	42	–	19	25	–
Plectranthus graveolens	8	–	19	–	–
Plectranthus parviflorus	50	–	62	13	100
Salvia plebeia	–	–	–	17	–
Scutellaria humilis	–	–	10	–	–
Teucrium argutum var. *incisum*	33	–	24	25	–
Liliaceae					
Arthropodium milleflorum	–	–	29	–	–
Dianella longifolia	33	–	29	42	100
Dianella revoluta	25	–	47	33	–
Hypoxis hygrometrica	33	–	5	–	–
*Lilium formosanum**	–	–	5	–	–
Thysanotus tuberosus	–	–	14	–	–
Tricoryne elatior	–	–	–	17	100
Linaceae					
Linum marginale	–	–	–	4	–
Lobeliaceae					
Lobelia purpurascens	50	–	33	75	–
Malvaceae					
Hibiscus trionum	–	–	–	–	100
*Malvastrum americanum**	–	–	–	13	–
*Modiola caroliniana**	–	–	–	4	–
Sida rhombifolia	–	–	5	4	–
Sida subspicata	–	–	14	71	–
Menispermiaceae					
Stephania japonica	8	–	–	–	–
Nyctaginaceae					
Boerhavia dominii	–	–	–	4	–
Onagraceae					
Epilobium billardierianum subsp. *cinereum*	42	100	48	50	–
Epilobium billardierianum subsp. *hydrophilum*	8	–	14	4	–
Orchidaceae					
Dipodium pulchellum	–	–	5	–	–
Pterostylis sp.	–	–	5	–	–
Oxalidaceae					
Oxalis corniculata	67	–	81	92	–
Philesiaceae					
Eustrephus latifolius	–	–	10	8	–
Geitonoplesium cymosum	–	–	10	–	–
Phytolaccaceae					
*Phytolacca octandra**	8	–	–	4	–
Plantaginaceae					
Plantago debilis	17	–	–	21	100
Poaceae					
Aristida ramosa	–	–	–	50	–
Bothriochloa bunyensis	25	–	5	17	–
Bothriochloa decipiens	–	–	–	8	–
Bothriochloa macra	8	–	–	33	100
Capillipedium parviflorum	–	–	14	13	–
*Cenchrus caliculatus**	–	–	19	4	–
Chloris divaricata	8	–	–	4	100
Chloris ventricosa	–	–	–	8	–
*Chloris virgata**	–	–	–	4	100
Cymbopogon refractus	–	–	65	83	100
Danthonia racemosa var. *obtusa*	–	–	–	4	–
Danthonia racemosa var. *racemosa*	–	–	5	–	–
Dichanthium sericeum	–	–	–	25	100
Dichanthium tenue	–	–	24	13	–
Dichelachne crinita	–	–	48	33	100
Dichelachne rara	–	–	14	–	100
Digitaria brownii	33	–	62	71	–
Digitaria diffusa	17	–	10	–	100
*Echinochloa frumentacea**	–	–	–	4	–
Echinopogon ovatus	–	–	–	8	–
Enneapogon gracilis	–	–	–	8	–
*Eragrostis curvula**	–	–	10	4	100
Eragrostis leptostachya	8.	–	5	21	–

	UPGMA group				
	1	2	3	4	5
Eriochloa procera	–	–	–	4	–
Imperata cylindrica	25	–	38	38	–
*Melinis repens**	–	–	5	–	–
Microlaena stipoides	67	–	19.	21	100
Oplismenus aemulus	17	–	5	–	–
Panicum effusum var. *simile*	8	–	–	50	–
Panicum queenslandicum	–	–	–	4	–
Paspalidium aversum	8	–	–	–	–
Paspalidium disjunctum	–	–	–	17	–
Paspalidium gracile	–	–	5	38	–
*Paspalum dilatatum**	17	100	14	4	100
Pennisetum alopecuriodes	8	–	–	4	–
*Pennisetum clandestinum**	17	–	5	–	–
Poa labillardieri	10	100	96	100	100
Setaria sphacelata var. *sericea**	–	–	–	4	–
Sorghum leiocladum	42	–	91	88	–
Sporobolus elongatus	33	–	57	54	100
Stipa ramosissima	8	–	5	–	–
Stipa scabra	–	–	–	12.5	–
Themeda triandra	17	–	91	42	100
Tripogon loliiformis	–	–	45	4	100
Polygalaceae					
Polygala japonica	–	–	14	8	–
Polygonaceae					
Rumex brownii	100	–	57	67	100
Portulacaceae					
Portulaca bicolor	–	–	–	–	100
Portulaca oleracea	–	–	–	8	100
Primulaceae					
*Anagallis arvensis**	8	–	19	–	–
Ranunculaceae					
Ranunculus lappaceus	33	–	57	13	100
Rosaceae					
Acaena anserinifolia	17	–	38	4	–
Rubus parvifolius	50	–	86	50	–
Rubiaceae					
Asperula conferta	25	–	38	25	100
Galium ciliare	8	–	52	–	–
Galium migrans	50	–	33	21	–
Santalaceae					
Thesium australe	–	–	10	–	–
Scrophulariaceae					
Mimulus gracilis	8	–	–	4	100
*Verbascum virgatum**	–	–	10	17	–
Veronica plebeia	42	–	24	38	–
Solanaceae					
*Solanum nigrum**	25	–	19	29	100
Solanum parvifolium	16	–	29	17	–
Solanum stelligerum	–	–	5	–	–
Solanum furfuraceum	17	–	–	–	–
Stackhousiaceae					
Stackhousia viminea	–	–	24	21	–
Thymeleaceae					
Pimelea neoanglica	25	–	10	25	–
Urticaceae					
Urtica incisa	58	100	5	4	–
Verbenaceae					
*Verbena bonariensis**	412	100	62	25	–
*Verbena officinalis**	33	–	62	49	–
*Verbena tenuisecta**	–	–	5	4	–
Violaceae					
Hybanthus stellarioides	8	–	71	79	100
Viola betonicifolia	33	–	48	33	–
Vitaceae					
Cayratia clematidea	67	–	43	33	–
Xanthorrhoeaceae					
Lomandra filiformis	–	–	–	4	–
Lomandra longifolia	17	–	24	8	100

* exotic plant taxa